**REMOTE-HANDLED
TRANSURANIC
SYSTEM ASSESSMENT**

**DOE/CAO-95-1143
Volume 1**

November 1995

**U. S. Department of Energy
Carlsbad Area Office
National TRU Program**

REMOTE-HANDLED

TRANSURANIC

SYSTEM ASSESSMENT

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Carlsbad Area Office
National TRU Program**

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ACRONYMS AND ABBREVIATIONS

AEA	Atomic Energy Act
ALARA	as low as reasonably achievable
ANL-E	Argonne National Laboratory - East
ANL-W	Argonne National Laboratory - West
APNEA	Active/Passive Neutron Examination and Assay
CAO	Carlsbad Area Office
C&C	Consultation and Cooperation Agreement - State of New Mexico
CH	contact handled
CTEN	Combined Thermal/Epithermal Neutron
D&D	decontamination and decommissioning
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
FEIS	Final Environmental Impact Statement
ft ³	cubic feet
FSEIS	Final Supplement Environmental Impact Statement
FTIR	Fourier Transform Infrared
ICV	Inner Containment Vessel
IDB	Integrated Data Base
INEL	Idaho National Engineering Laboratory
KAPL	Knolls Atomic Power Laboratory - Schenectady
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restriction
LINAC	linear accelerator
LWA	WIPP Land Withdrawal Act
m ³	cubic meters
NDA	non-destructive assay
NDE	non-destructive examination
NRC	Nuclear Regulatory Commission
NRF	Nuclear Reactors Facilities
OCV	Outer Containment Vessel
ORNL	Oak Ridge National Laboratory
PAN	Passive-Active Neutron
PEIS	Programmatic Environmental Impact Statement
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
R&D	research and development
RCRA	Resource Conservation and Recovery Act
rem	Roentgen Equivalent Man
RGS	Residual Gas System

RH	Remote-handled
RTR	Real Time Radiography
SAR	Safety Analysis Report
SARP	Safety Analysis Report for Packaging
SGS	Segmented Gamma Scan
SRS	Savannah River Site
TRU	transuranic
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WNP	Washington Nuclear Power
WPPSS	Washington Public Power Supply System
WTWBIR	Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report

EXECUTIVE SUMMARY

This document identifies the necessary actions for addressing current questions concerning the safe and efficient disposal of remote-handled transuranic wastes that have been generated through Department of Energy activities. In addition, this document presents summaries of existing information and analyses regarding the potential alternatives for disposing of remote-handled (RH) transuranic (TRU) waste at the Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP). A further discussion of DOE's approach for addressing RH-TRU issues is contained in the document, *Waste Isolation Pilot Plant Remote-Handled Transuranic Waste Disposal Strategy*, DOE/WIPP-95-1090 (DOE, 1995a).

The WIPP will begin receiving contact-handled (CH) TRU waste in April 1998, and RH-TRU waste in the year 2002. The current WIPP authorized disposal capacity is less than that needed to dispose of the national inventory of defense-related RH-TRU waste. The authorized WIPP RH-TRU waste capacity is 7,080 cubic meters (m^3) (250,000 cubic feet [ft^3]). At this time, the RH-TRU waste inventory is estimated to be 1,170 m^3 (41,314 ft^3), and the projected RH-TRU waste inventory is estimated to be 3,620 m^3 (127,825 ft^3) through the year 2022, according to Revision 1 of the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* (WTWBIR) (DOE, 1995b). In addition, there is a significant additional inventory of "suspect" waste at Hanford, some of which will be categorized as RH-TRU. With this additional quantity, the national RH-TRU waste inventory exceeds the authorized WIPP capacity of 7,080 m^3 (250,000 ft^3). It should be noted that, in most cases, the projected inventory consists of radioactive material which has been generated, but has not yet been packaged as waste. The bulk of this projected inventory will come from activities at the Hanford Reservation. RH-TRU wastes to be generated beyond the year 2022 have not been estimated at this time.

Of this stored and projected inventory, approximately 30% can be characterized with current technology and subsequently certified to meet the waste acceptance criteria for disposal at WIPP; characterization of the remaining 70% will require the use of alternative techniques. At most of the generator sites, characterization equipment and facilities need to be procured in order for the sites to certify waste for shipment either to WIPP or to an interim site. If surface dose rates are too high, the use of non-invasive techniques such as non-destructive examination (NDE) and non-destructive assay (NDA) may be precluded. Characterization methods using NDA can be effectively used on RH-TRU wastes with surface dose rates of less than 1.0 rem/hr (neutron); NDE methods are effective on waste with surface dose rates of less than 10 rem/hr (gamma). The ability to use current NDE technology on waste with surface dose rates above 10 rem/hr will need to be demonstrated. Alternate characterization techniques, such as examination within a hot cell, could be used for the remaining waste; however, such techniques are labor intensive and would require additional effort to gather assay data. Improvements in characterization capabilities are being pursued through future technology development initiatives.

New technologies or capabilities, such as mobile characterization units, can be developed to increase the ability to characterize RH-TRU waste. These improved capabilities will emphasize attention to safety and health while improving and maximizing characterization capabilities and throughput. Characterization will also be more easily achieved where process records or other acceptable knowledge records are available. In addition, since final state and EPA permits have not been issued, the ultimate waste characterization requirements have not been finalized.

To achieve the goals desired for this document, multiple alternatives or options have been evaluated to develop the actions described herein. These alternatives or options are summarized in this document and described in greater detail in the companion appendices contained in Volume 2. The central point of comparison for these analyses is that the design basis disposal configuration reflects the authorized disposal limit for RH-TRU waste of 7,080 m³ (250,000 ft³). As a practical matter, this capacity is further reduced to about 4,780 m³ (168,785 ft³) because of the facility layout and emplacement equipment that has been selected for use (see Section 8.1). The current configuration requires that RH-TRU wastes be emplaced preceding the emplacement of CH-TRU wastes; therefore, the scheduled receipt of CH-TRU wastes four years prior to the receipt of the first RH-TRU waste results in an additional loss of 500 m³ (17,655 ft³) of RH-TRU storage capacity. The estimated capability for disposal of RH-TRU waste, therefore, is about 4,280 m³ (151,130 ft³). Several relatively simple solutions could increase this capacity, such as widening some of the access drifts to allow for emplacement of RH-TRU waste.

One way to maintain disposal capacity at WIPP is to use shielded payload containers filled with RH-TRU waste which could be handled at the WIPP as CH-TRU waste. This option increases the amount of RH-TRU waste which may be removed from the generator/storage sites and then be safely and efficiently managed and disposed of at WIPP within current regulatory guidelines.

Alternate NRC-certified Type B transportation packaging has been identified which could allow certain waste types and forms to be transported both between sites (for treatment or interim storage) and to WIPP. In conjunction with the RH-72B, these alternate payload containers and packagings could provide additional system-wide flexibility while improving the ability to manage RH-TRU waste. For the small-quantity sites, the ability to consolidate detailed characterization, treatment, and packaging capabilities at regionalized facilities, such as ORNL for the eastern part of the United States and Hanford for the western part of the United States, could prove very beneficial. However, RH-TRU waste must be characterized sufficiently to meet transportation requirements.

Several conclusions which reflect the current constraints on the National TRU Program have been reached from this RH-TRU System Assessment:

- Stored and projected RH-TRU waste inventories will exceed the authorized disposal capacity of WIPP.
- Specific waste characterization requirements for RH-TRU waste have not been completely identified.
- Current NDE and NDA technologies allow characterization of a portion of RH-TRU wastes, but new or improved capabilities are required for characterization of all RH-TRU waste.
- Facilities and/or equipment at some generator sites will need to be modified to accommodate the current design basis configuration for packaging RH-TRU waste in canisters.
- The transportation design basis configuration can accommodate the anticipated throughput rates, assuming the generator sites are able to load the waste for shipment.
- The design basis disposal configuration will emplace less RH-TRU waste than the amount allowed.

From these conclusions, the following overall program strategy may be derived. This strategy is divided into two parts. The first pertains to the near-term actions required to ensure initial shipments of RH-TRU waste to WIPP by the year 2002, and the second involves long-term actions required for sustained shipments over the disposal period.

Near-term Actions

- Clarify the waste acceptance and characterization requirements for RH-TRU wastes. The WIPP Quality Assurance Program Plan (QAPP) and site-specific Quality Assurance Project Plans will be modified to include specific RH-TRU waste characterization guidelines. This activity will be coordinated with EM-50, Office of Technology Development, to develop characterization technology for both near-term and long-term needs.
- Complete the final certification process for the RH-72B cask.
- Modify the TRUPACT-II Certificate of Compliance and other necessary requirements documents to allow shipments of shielded payload containers.

- Prepare the WIPP RH-TRU waste handling equipment and facilities for receiving RH-TRU waste.
- Begin characterizing and packaging RH-TRU waste at the generator sites for transportation and subsequent disposal at WIPP. The Los Alamos National Laboratory and the Oak Ridge National Laboratory should be prepared to be the first sites to ship RH-TRU waste.
- Complete privatization decision by ORNL in fiscal year 1997.
- Decide on disposal and packaging/transportation configuration for initial receipt of RH-TRU waste as soon as possible.

Long-term Actions

- Identify and implement selected disposal and packaging/transportation alternatives to remove the greatest possible amount of RH-TRU waste within regulatory and permitting limitations.
- Enhance characterization technologies and capabilities and/or facilities for NDE and NDA.

REMOTE-HANDLED TRANSURANIC WASTE SYSTEM ASSESSMENT

1.0 INTRODUCTION

This document provides a summary of existing information and analyses regarding the potential alternatives for disposing of remote-handled (RH) transuranic (TRU) waste at the Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP). It represents the culmination of the initial step in developing an integrated RH-TRU System Assessment. This assessment consists of six elements: 1) Inventory and Generation, 2) Site Storage, 3) Treatment, 4) Characterization, 5) Packaging and Transportation, and 6) Disposal. The analyses and data used to develop each of these elements are provided as Appendices A through F to this document. A discussion of DOE's approach for addressing RH-TRU issues may be found in the *Waste Isolation Pilot Plant Remote-Handled Transuranic Waste Disposal Strategy*, DOE/WIPP-95-1090 (DOE, 1995a).

As stated in the above-referenced Disposal Strategy, the objectives of this RH-TRU assessment are as follows:

- Near-term: Provide a plan to ensure that initial disposal of RH-TRU waste will commence in fiscal year 2002;
- Long-term: Provide a strategic approach to ensure efficient and sustained disposal during the operating life of WIPP.

RH-TRU waste for disposal at WIPP is limited to radioactive waste resulting from defense activities and defense programs of the United States Government exempted from regulation by the United States Nuclear Regulatory Commission (NRC). Excluded from WIPP are any radioactive waste generated by the commercial nuclear power industry.

The RH-TRU defense-waste inventory can be further subdivided into TRU waste and mixed-TRU waste. Mixed-TRU waste is TRU waste that also contains hazardous constituents as defined by the Resource Conservation and Recovery Act (RCRA) (U.S. Congress, 1976 as amended). Because of the presence of hazardous waste, mixed-TRU waste is subject to dual regulation under the Atomic Energy Act (AEA) (U.S. Congress, 1954 as amended) and the RCRA. The majority of existing RH-TRU waste is categorized as mixed-TRU.

RH-TRU defense waste has a variety of origins. Most of the RH-TRU waste originates from research and development (R&D) and production operations. Additionally, a considerable amount of waste is derived from decontamination and decommissioning (D&D) activities and from treatment activities.

1.1 Scope

The following matters are addressed in this report:

- The inventory of existing and projected RH-TRU waste in the National TRU system (Section 2.0).
- The sites' ability to maintain sufficient storage capacity to allow sustained RH-TRU disposal activities (Section 3.0).
- The sites' current RH-TRU characterization capabilities, the limitations in current characterization technology, and potential technological developments or improvements for RH-TRU waste characterization (Section 4.0).
- The available and planned treatment options (Section 5.0).
- The available and potential packaging and transportation options (Section 6.0).
- The disposal design basis and potential disposal options (Section 7.0).
- The design basis for the RH-TRU waste system and proposed alternatives to the design basis (Section 8.0).
- The conclusions reached as a result of this assessment and the proposed actions for optimizing the RH-TRU waste system, both for near-term and for long-term, sustained disposal operations (Section 9.0).

1.2 Regulatory Requirements Affecting RH-TRU Waste

Public Law 96-164, which authorized WIPP, restricted the waste being sent to WIPP to defense waste. Specifically, the WIPP was authorized to "demonstrate the safe disposal of radioactive waste resulting from defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission" (U.S. Congress, 1980). Subsequently, and in conjunction with the limits on disposal of contact-handled transuranic (CH-TRU) waste at WIPP, the amount of RH-TRU waste which could eventually be disposed of at WIPP was limited to approximately 7,080 m³ (250,000 ft³). This was first established in the Record of Decision for the WIPP Final Environmental Impact Statement (FEIS) (DOE, 1981), and is also the authorized limit specified in the Final Supplement Environmental Impact Statement (FSEIS) (DOE, 1990a) and the First Modification to the July 1, 1981 Agreement for Consultation and Cooperation with the State of New Mexico (New Mexico, 1984).

In 1992, Congress issued Public Law 102-579, the *Waste Isolation Pilot Plant Land Withdrawal Act* (LWA), which withdrew the land designated for WIPP use from public land laws and transferred jurisdiction of the 16-square mile area to the Department of Energy. In addition, the LWA contained limitations on the RH-TRU waste to be sent to WIPP that were nearly identical to those originally set forth in the First Modification to the Consultation & Cooperation (C&C) Agreement with the state. The primary difference is that the C&C Modification limits the maximum amount of RH-TRU waste that can be shipped to WIPP to 7,080 m³ (250,000 ft³), while the LWA does not set a specific limit on WIPP's RH-TRU waste capacity. The LWA sets forth the total capacity of WIPP, by volume, as "6.2 million cubic feet of transuranic waste" and does not differentiate between CH-TRU and RH-TRU waste (U.S. Congress, 1992). The LWA contains the following rem and curie limits:

- No transuranic waste received at WIPP may have a surface dose rate in excess of 1,000 rems per hour.
- No more than 5 percent by volume of the remote-handled transuranic waste received at WIPP may have a surface dose rate in excess of 100 rems per hour.
- Remote-handled transuranic waste received at WIPP shall not exceed 23 curies per liter maximum activity level (averaged over the volume of the canister)
- The total curies of the remote-handled transuranic waste received at WIPP shall not exceed 5,100,000 curies.

These limits basically mirror those contained in the C&C modification, except that the Modification sets a limit of 354 m³ (12,500 ft³) on the maximum volume of waste over 100 rem/hr that can be shipped to WIPP, as follows:

- No more than 5% of the total volume of 250,000 cubic feet (or 12,500 cubic feet maximum) of defense RH-TRU shipped to WIPP will exceed 100 rem per hour surface dose rate. (emphasis added)

1.3 Data Sources

Revision 1 of the *Waste Isolation Pilot Plant Transuranic Waste Baseline Inventory Report* (WTWBIR) (DOE, 1995b) served as the primary data source for this report. The WTWBIR contains the most current information on RH-TRU waste inventories and projected generation estimates. Other data sources include the *Mixed Waste Inventory Report* (DOE, 1993) and the *Integrated Data Base* (IDB) (DOE, 1994).

1.4 Evaluation Criteria

Alternatives presented in this report were evaluated against three primary criteria:

- **Risk.** This criterion was used to rate each alternative against the WIPP Final Safety Analysis Report (SAR) design basis accident scenarios in the areas of personnel and industrial safety, environmental safety and public health, and as-low-as-reasonably-achievable (ALARA) considerations.
- **Throughput rates and volume emplaced.** This criterion assessed how alternatives would affect disposal system operations, the transportation system, support system operations, facility and equipment maintenance functions, throughput rates and the ultimate disposal volume of CH- and RH-TRU waste, and how generator/storage sites would be affected.
- **Cost.** Each alternative was considered against the costs associated with new facilities or modifications, startup costs, and system operations and maintenance.

For some of the analyses comprising this study, sub-criteria were developed beneath these primary criteria. As appropriate, the sub-criteria are discussed in their respective sections of this report and the supporting appendices.

2.0 WASTE INVENTORY AND GENERATION

The following generator/storage sites have been included in this assessment because they store existing RH-TRU inventories and/or project future generation of RH-TRU waste.

- Argonne National Laboratory-West (ANL-W),
- Battelle Columbus Laboratory Decommissioning Project (Battelle),
- Bettis Atomic Power Laboratory (Bettis), and
- Hanford Reservation (Hanford),
- Idaho National Engineering Laboratory (INEL),
- Knolls Atomic Power Laboratory (KAPL),
- Los Alamos National Laboratory (LANL), and
- Oak Ridge National Laboratory (ORNL).
- Savannah River Site (SRS).

Of these nine sites, only Battelle, Bettis, and SRS do not report stored RH-TRU waste inventories. Several "small-quantity" sites have also been identified and are also being evaluated.

2.1 Current and Projected Inventories

The current stored inventory of RH-TRU waste in the DOE system totals about 1,170 m³ (41,314 ft³), approximately 85 % of which is found at ORNL (DOE, 1995b). The WTWBIR projects that an additional amount of 3,620 m³ (127,825 ft³) of RH-TRU waste will be generated through the year 2022, for a total of about 4,800 m³ (169,492 ft³). Table 2-1 shows the quantities of waste currently stored at the nine major DOE sites, as well as the projected waste these sites will generate.

In addition to the waste volumes shown for Hanford, an additional 43,000 m³ (1,518,362 ft³) of "suspect" mixed RH-TRU waste has been reported by Hanford in previous data submittals; however, insufficient information was available about the waste to allow it to be categorized as RH-TRU in Revision 1 of the WTWBIR (DOE, 1995b). Data to be provided by Hanford for the next revision of the WTWBIR¹ will provide additional information on how much of this waste can be defined as RH-TRU.

2.2 Curie Content

The LWA limits the curie content of waste that can be emplaced in the WIPP to 23 curies per liter, with the total for all waste emplaced not to exceed 5.1 million curies (U.S. Congress, 1992). The total curies of existing and future RH-TRU waste will be below the 5.1 million curie limit imposed by the LWA. Based on current estimates derived from data contained in the current WTWBIR and from the 1994 IDB (Revision 10), the average specific activity of the majority of RH-TRU waste to be emplaced at WIPP is below 23 curies per liter. Any RH-TRU waste destined for disposal at WIPP that exceeds this curie limit will be treated and repackaged to acceptable limits before being disposed of at WIPP.

2.3 Estimated Dose Rates

Estimates of RH-TRU dose rates were provided for selected DOE facilities, as shown in Table 2-2. These dose rate estimates were provided as ranges and were segregated between existing retrievably stored RH-TRU waste and projected RH-TRU waste. The estimates were based on data submitted by generator sites for preparation of the 1991 IDB (DOE, 1992) and from engineering judgment. Section 3.0 of Appendix C contains a more detailed discussion of how these estimates were calculated.

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¹Revision 2 of the WTWBIR is scheduled to be issued in December 1995.

2.4 Waste Categories

For ease of analysis, RH-TRU wastes may be separated into seven generalized categories based on similar characteristics. Approximately 78% (3762 m³/ 132,854 ft³) of the existing and projected RH-TRU waste is in the *Heterogenous* category. About 16% (787 m³/27,793 ft³) is designated as *Solidified Inorganic*. This category includes waste that is in non-solid form, such as sludge, which requires further treatment. Essentially all of the waste in this category is at ORNL, but Hanford and INEL also have a small amount of sludges. Approximately 4% (174 m³/ 6,151 ft³) is listed as *Uncategorized Metal*. The other categories are *Combustible* (18 m³/636 ft³), *Filter* (3 m³/105 ft³), *Lead/Cadmium Metal* (6 m³/ 210 ft³), *Salt Waste* (3 m³/105 ft³) and *Unknown* (35 m³ /1,231 ft³). The last category includes some miscellaneous waste forms and a variety of waste which has not been characterized sufficiently to accurately categorize the waste. See Appendix A for more detailed information on waste categories.

Table 2-1. RH-TRU Waste Disposal Inventory by Site¹

SITE	STORED WASTE	PROJECTED WASTE	TOTAL WASTE
ANL-W	9 m ³ (307 ft ³)	28 m ³ (132 ft ³)	36 m ³ (1282 ft ³)
BATTELLE	0.0	71 m ³ (2507 ft ³)	71 m ³ (2507 ft ³)
BETTIS	0.0	2 m ³ (56.5 ft ³)	2 m ³ (56.5 ft ³)
HANFORD	33 m ³ (1165 ft ³)	2974 m ³ (105,004 ft ³)	3007 m ³ (106,169 ft ³)
INEL	31 m ³ (1095 ft ³)	17 m ³ (593 ft ³)	48 m ³ (1688 ft ³)
KAPL	11 m ³ (395 ft ³)	25 m ³ (889.83 ft ³)	36 m ³ (1285 ft ³)
LANL	91 m ³ (3224 ft ³)	83 m ³ (2920 ft ³)	174 m ³ (6145 ft ³)
ORNL	994 m ³ (35,092 ft ³)	357 m ³ (12,592 ft ³)	1351 m ³ (47,687 ft ³)
SRS	0.0	64 m ³ (2256 ft ³)	64 m ³ (2256 ft ³)
TOTAL RH- TRU VOLUMES	1169 m ³ (41,282 ft ³)	3619 m ³ (127,797 ft ³)	4788 m ³ (169,078 ft ³)

¹ Source: WTWBIR (DOE, 1995b), Tables 3-16 through 3-23

Table 2-2. Estimation of Surface Dose Rates for RH-TRU Waste Containers¹

Site	Projected ² or Stored ³	Dose Rate (rem/hr)				
		0.2-1.0	1 - 10	10 - 50	50 - 100	>100
INEL ⁴	Stored	2%	56%	40%	1%	1%
INEL ⁵	Projected	0%	0%	100%	0%	0%
ANL-W	Stored	0%	0%	31%	69%	0%
ANL-W	Projected	0%	0%	0%	0%	100%
LANL	Stored	0%	18%	27%	55%	0%
LANL	Projected	0%	0%	38%	19%	43%
ORNL	Stored	3%	18%	6%	73%	<1%
ORNL	Projected	0%	31%	12%	32%	25%
Hanford	Stored	40%	34%	1%	25%	0%
Hanford	Projected	N/A	N/A	N/A	N/A	N/A

¹Source: Values were derived from 1991 Integrated Data Base Data submittals and engineering judgment for the purpose of estimating RH-TRU dose rates and their potential impact on related activities such as characterization.

²Projected - Projected or future waste inventories

³Stored - Retrievably stored or existing waste inventory

⁴Includes ANL-E, Test Reactor Area, and the Nuclear Reactors Facilities (NRF)

⁵Includes Bettis and NRF.

N/A - Not Available

3.0 WASTE STORAGE REQUIREMENTS

3.1 Capacity Requirements

Requirements for site storage capacity are based on the amount of waste that should be kept in storage in order to ensure that waste is shipped to WIPP at a sustainable, steady rate. Without adequate site storage capability, an operational disruption at either the generator site or WIPP could lead to a slowdown or cessation of system-wide operations. Small-quantity generator sites are not anticipated to require a significant amount of storage because each of these sites has relatively small amounts of waste. In most cases, their shipments will be made shortly after their waste has been characterized and certified, or on an "as-generated" basis.

3.2 Preferred Alternatives for Storage

The sites with the greatest current need for RH-TRU waste storage are Hanford, ORNL, LANL, and INEL. Table 1 in Appendix B of this document contains detailed information on the shipping schedules and waste storage needs for these sites. Bettis, Battelle, KAPL, SRS, and ANL-W² are considered small-quantity generator sites and require minimal RH-TRU waste storage capacity. Of the four sites that require significant RH-TRU waste storage capacity, LANL and INEL each have existing facilities that will sufficiently meet their storage requirements. Hanford may require additional storage facilities, while ORNL has storage planned and under construction.

3.2.1 Idaho National Engineering Laboratory

The peak storage capacity needed at INEL is for up to four canisters ($4 \text{ m}^3/126 \text{ ft}^3$)³ are during years 2002-2008 (DOE, 1995b). Currently, INEL has three RCRA-permitted vaults which would provide about 5 m^3 (177 ft^3) of storage. These existing vaults will provide sufficient storage capacity to meet INEL's needs and thus no additional facilities will be required.

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²Preliminary data submitted by ANL-W for Revision 2 of the WTWBIR indicate a significant increase in the projected generation of RH-TRU waste; however, it is expected that the existing RCRA-permitted storage facility at ANL-W will provide sufficient capacity for storage of the projected waste.

³Volumes given are external canister volumes.

3.2.2 Los Alamos National Laboratory

During the years 2002-2014, LANL will require storage capacity for a maximum of eight canisters ($7 \text{ m}^3/251 \text{ ft}^3$) (DOE, 1995b). At this time, there are approximately 20 burial-site shafts that contain waste previously certified to an earlier version of the WIPP Waste Acceptance Criteria (WAC). These will need to be certified to meet the current WAC. When this waste is certified to the current WAC and shipped to WIPP, the shafts can be reused as storage. Therefore, it is expected that no additional storage facilities will be required.

3.2.3 Oak Ridge National Laboratory

Although ORNL has one existing facility (Building 7885) that could be used for storage, it is nearly filled to capacity. Therefore, the preferred storage alternative for ORNL is to proceed with construction of two facilities currently planned: Building 7883, now under construction and scheduled to be operational in 1997, and proposed Building 7884. Building 7883 is partially committed for storage of newly-generated RH-TRU waste, but currently, 60% of its capacity ($40 \text{ m}^3/1,412 \text{ ft}^3$) is available, which will be sufficient to meet ORNL's needs until 2017 (DOE, 1995b). Building 7884 (if constructed) would then provide the necessary capacity to meet ORNL's remaining storage requirement, which peaks at 80 canisters ($71 \text{ m}^3/2,507 \text{ ft}^3$) in 2019 (DOE, 1995b).

3.2.4 Hanford Reservation

Hanford has the largest demand for RH-TRU waste storage. Its storage need peaks at 128 canisters ($114 \text{ m}^3/4,025 \text{ ft}^3$) in 2015 and remains constant until 2025 (DOE, 1995b). Although the existing Fuel Materials Examination Facility, if modified, could be used for RH-TRU waste storage, there is a strong demand among other groups to use this facility for other purposes; thus, its use as a storage facility is unlikely. Assessments at Hanford have identified the unfinished Washington Nuclear Power (WNP) #1 reactor facility (one of the Washington Public Power Supply System [WPPSS] reactors) as a possible alternative location for storage and treatment of radioactive wastes. The WNP #1 facility would require extensive retrofitting but, when complete, would provide handling and storage not only for RH-TRU waste, but also for a variety of other radioactive wastes (e.g., high-level waste, CH-TRU waste, and waste from miscellaneous sources). Other options would include building a facility specifically designed for RH-TRU waste storage.

4.0 CHARACTERIZATION

4.1 Requirements

A comparison of CH- and RH-TRU characterization methodologies with current WIPP WAC characterization requirements is presented in Exhibit A. The current WIPP WAC (DOE, 1991a) identified and consolidated existing criteria and requirements which regulate the safe handling and preparation of TRU waste packages for transportation to and emplacement in the WIPP. The WIPP WAC requirements are primarily focused on CH-TRU waste certification for disposal at WIPP. Currently, specific requirements for RH-TRU wastes are limited. The requirements used in the current WIPP WAC (Revision 4) originated from four sources, which are briefly described below.

- WIPP Operations and Safety Criteria

These are the criteria developed to ensure safe handling of wastes at the WIPP. They are set forth in the *WIPP Final Safety Analysis Report* (DOE, 1990b) and the Waste Handling Operations System Design Description (DOE, SDD-WHOO) and are incorporated into each revision of the WIPP WAC.

- Transportation: Waste Package Requirements

Certification requirements for transportation of RH-TRU wastes will not be finalized until a Safety Analysis Report for Packaging (SARP) is approved by the NRC for Type B packaging of RH-TRU waste and a Certificate of Compliance is issued. However, Exhibit A contains preliminary requirements from the draft RH-TRU Cask SARP currently under review by the DOE prior to submittal to the NRC (VECTRA, 1994).

- Resource Conservation and Recovery Act Requirements

As described previously, much of the RH-TRU waste in the DOE system is mixed with hazardous constituents and is regulated by both the AEA and RCRA. Exhibit A includes a summary of the requirements/criteria listed in the WIPP RCRA Part A and Part B Permit Applications (DOE, 1991b; DOE, 1993).

- Performance Assessment Criteria

The Performance Assessment waste characterization criteria that are contained in the WIPP Quality Assurance Program Plan (QAPP) (DOE, 1995c) were included in the current WIPP WAC.

4.2 Waste Characterization Technologies

There are three technologies which dominate the methodologies currently used for characterization of CH-TRU waste: non-destructive assay (NDA) methods such as Passive Active Neutron (PAN) and Segmented Gamma Scanner (SGS) systems; non-destructive examination (NDE) systems such as Real-Time Radiography (RTR) and Tomography; and gas sampling and analysis. These technologies are further described below. In addition, many of the waste characterization requirements and criteria are achieved through existing process controls/knowledge, administrative controls, procurement controls, or by calculations based on existing data.

- **Non-destructive Assay** - radioassay methods used to identify and quantify radionuclides in TRU waste.
  - Neutron Interrogation - the use of neutron measurement techniques to identify and quantify the radionuclides in TRU waste.
  - Segmented Gamma Scan - the use of gamma measurement techniques to identify and quantify the radionuclides in TRU waste.
- **Non-destructive Examination** - methods that use x-rays to inspect and determine the physical form of waste.
- **Gas Sampling and Analysis** - methods for obtaining samples and measuring the concentrations of headspace gases.

At this time, NDA/NDE methods can be applied to certain RH-TRU waste containers, based on surface dose rates. Gas Sampling and Analysis can be applied to all RH-TRU waste, regardless of surface dose rate. Surface-dose-rate levels are important because the more intense radiations emitted by higher dose rate containers interfere with the instrumentation used by some NDE/NDA methods. In order to estimate the potential use of these technologies for RH-TRU waste characterization, waste was categorized into one of two groups: a "Low Surface Dose Rate" group or a "High Surface Dose Rate" group. The level above which the existing CH-TRU instrumentation may become unsuitable for characterization of RH-TRU wastes was estimated for both NDA and NDE technologies. The "Low Surface Dose Rate" group falls below the threshold level and can be adequately characterized by the existing systems, with limited modifications to the equipment. Waste with dose rates above the threshold fall into the "High Surface Dose Rate" group and may need to be characterized with new or improved technology, except in cases where there is

acceptable knowledge⁴. Acceptable knowledge can be used in lieu of NDA/NDE methods.

The threshold surface dose rates (at the surface of the waste container) for the two methodologies are currently estimated to be:

- NDE (e.g., Real-Time Radiography)
10 rem/hr gamma; 1 rem/hr neutron (proven technology)
- NDA (e.g., PAN, SGS)
1 rem/hr gamma; 0.1 rem/hr neutron.

The above estimates of NDE surface dose rate thresholds are based on currently proven technology. However, specifications have been obtained from manufacturers of NDE equipment such as RTR and computer tomography which indicate that analysis of RH-TRU waste with surface dose rates up to 1,000 rem/hr (gamma) is possible. However, such systems have not been tested on "High-Surface-Dose-Rate" RH-TRU waste.

The most recent RH-TRU waste inventory data provided by the sites for the WTWBIR did not contain surface dose rate information. These data were last collected informally by DOE in conjunction with the IDB submittals for calendar year 1991 and were provided as surface dose rates for discrete ranges. Using these data, rough estimates as to what percent of the stored volume would occur below a given dose rate were developed. The method used to make these estimates is described in Appendix C. Based on these estimates, about 30% of the RH-TRU waste scheduled for eventual disposal at WIPP could be characterized with existing non-destructive technology. This includes the sludges stored at ORNL which appear to be characterizable using currently available technology. The remainder of the RH-TRU waste inventory would have to be characterized destructively in higher risk operations, or characterization delayed until improved technology becomes available.

4.3 **RH-TRU Waste Characterization Capabilities**

The existing and planned RH-TRU waste characterization equipment and facilities at ANL-E, ANL-W, INEL, Hanford, LANL, and ORNL are summarized in the table attached as Exhibit B. The following sections summarize RH-TRU characterization needs by equipment or facilities.

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⁴As defined by the Environmental Protection Agency (EPA), acceptable knowledge includes process knowledge and results from previous testing, sampling, and analysis associated with the waste. It also includes information regarding the raw materials used in a process or operation, the process description, and the products and associated wastes produced by the process.

4.3.1 Real-time Radiography Equipment

All RH-TRU sites listed in Exhibit B have an RTR unit available for characterization of CH-TRU waste, except ANL-E, which plans to do 100% visual examination. These RTR units could possibly be modified to characterize "Low-Surface-Dose-Rate" RH-TRU waste. As discussed previously, this would apply to approximately 30% of the RH-TRU inventory. The remaining 70% of "High-Surface-Dose-Rate" waste requires the development of a new technology or modification of an existing technology; otherwise, a large number of RH-TRU waste containers will have to be opened in a hot cell and visually characterized.

4.3.2 Radioassay Equipment

As shown in Exhibit B, several RH-TRU facilities have a CH-TRU PAN system for radionuclide inventory determinations on CH-TRU wastes. ANL-E and ANL-W both have SGSs for RH-TRU, but these may be insufficient for determining radionuclide inventories for meeting WIPP WAC requirements. These systems could potentially be modified to characterize RH-TRU waste below the NDA thresholds for "Low Surface Dose Rates." However, there remains a need to develop new technology or modify an existing technology to achieve a system which can meet the WIPP WAC requirements for radionuclide characterization of RH-TRU waste with "High Surface Dose Rates."

Three systems that show promise for radioassay of RH-TRU waste containers with "High Surface Dose Rates" are under development. Two systems are being developed at ORNL: the linear accelerator (LINAC) PAN type system and the Active/Passive Neutron Examination and Assay (APNEA). A Combined Thermal/ Epithermal Neutron (CTEN) Interrogation radioassay system is being developed at LANL. These systems should be pursued in the future to support non-destructive or non-invasive characterization activities for RH-TRU waste.

4.3.3 Gas Sampling and Analysis Equipment

Gas Sampling and Analysis Units produce gas samples that are nonradioactive and can be analyzed outside a glovebox/hot cell environment. Therefore, the issues of sampling for headspace gases and analysis by a qualified laboratory can be separate activities. Presently, ANL-W, ANL-E, INEL, the Rocky Flats Environmental Technology Site (RFETS) and one contractor laboratory have qualified under the Performance Demonstration Program⁵ for gas analysis of TRU waste. Sites that sample for gases can

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⁵The Performance Demonstration Program requires that each facility demonstrate its ability to analyze samples in compliance with QAPP Quality Assurance objectives by successfully analyzing blind audit samples. Acceptable performance must be demonstrated by all participating facilities prior to the initial analysis of TRU waste

send a gas sample offsite, if needed, for analysis. This allows greater flexibility in the DOE system for analyses of headspace gases from RH-TRU waste containers.

A Fourier Transform Infrared (FTIR) system (for organic gases) has been installed at ANL-W. This unit allows at-site sampling analysis (non-invasive), without the collection of gases in sample containers. A portable version of the FTIR with a Residual Gas System for inorganic gases (FTIR/RGS) is being developed by ANL-W/INEL. This system could be used throughout the entire RH-TRU system for sampling and analysis of headspace gases. The individual sites would only have to supply the area for placement of the RH-TRU container and insertion of the sampling apparatus into the container. Generally, this would be done in a hot cell similar to that described in the next section on "Visual Examination."

4.3.4 Visual Examination Facilities

Most existing RH-TRU waste was originally generated in hot cells at the various DOE sites. Therefore, although modifications are required in most instances, sites should have facilities available to perform visual examination of RH-TRU waste and to provide an area for sampling of gases in the waste container.

4.3.5 Summary

RH-TRU waste characterization capabilities are available to certify a portion of the RH-TRU waste destined for shipment to WIPP. However, capabilities must be improved to ensure that all waste can be characterized for shipment to and disposal at WIPP. Activities required to ensure both initial shipments of RH-TRU waste to WIPP (near-term) and sustained shipments over a lengthy period (long-term) include the following:

Near-term Activities

- Clarify waste acceptance requirements for RH-TRU wastes.
- Revise the WIPP QAPP and the site-specific Quality Assurance Project Plans (QAPjPs) to include specific data requirements for RH-TRU waste.
- Identify the portion of the RH-TRU waste inventory for which documented "acceptable knowledge" exists.

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samples, as well as on a continuing basis (DOE, 1991c).

- Identify the portion of the RH-TRU waste inventory which can be characterized using existing characterization technology.

Long-term Activities

- Improve NDE/NDA characterization technology for RH-TRU waste which cannot be characterized with existing technology (e.g., "High Surface Dose Rate" waste).
- Improve or modify existing characterization equipment for mobile use.
- Revise characterization requirements to allow alternative characterization methods that take into consideration information obtained from risk/benefit analyses and that meet ALARA principles.

5.0 TREATMENT

5.1 Requirements

Estimates based on site-specific knowledge and/or process knowledge of the waste at each site, knowledge of what would be required for shipment of the waste to WIPP, and assumptions about which types of RH-TRU waste would require repackaging or treatment, indicate that most retrievably stored RH-TRU waste needs to be treated and/or repackaged in order to meet WIPP WAC requirements. It is DOE policy that TRU waste will be treated to the extent necessary to meet the WIPP WAC rather than to meet the land disposal restrictions (LDRs) applicable to waste containing hazardous constituents as specified in 40 CFR 268. This is because treatment of the waste destined for WIPP to meet the LDRs will not be required since it is expected that the DOE's No-Migration Variance Petition (DOE, 1990c) will be approved by the EPA. However, to dispose of the excess RH-TRU waste that will exist after WIPP reaches its maximum capacity, it may be necessary to meet LDR requirements. Under this scenario, it may be more cost-effective to treat waste to meet LDR requirements rather than segregating and treating the waste to meet different treatment standards.

The Programmatic Environmental Impact Statement (PEIS) presently being prepared by the DOE will address the management of all DOE waste. The RH-TRU waste treatment alternatives considered in the draft PEIS include two facility configurations and three treatment options. The facility configurations for RH-TRU waste management are designated Decentralized and Regionalized.

5.2 Facility Configurations

5.2.1 Decentralized

The decentralized treatment configuration is very similar to the current design basis configuration which was modeled using five sites: Hanford, INEL, LANL, ORNL, and ANL-E. In this configuration each site that currently stores or generates RH waste will have facilities for retrieving, repackaging, characterizing, certifying, and loading RH-TRU waste for shipment.

5.2.2 Regionalized

In this configuration, large regional treatment plants would be located at Hanford and ORNL. Generator sites would send RH-TRU waste requiring treatment to one of these facilities. This configuration assumes the RH waste is or can be adequately characterized for shipment. After the waste is treated, it would be shipped directly to the WIPP site for disposal.

5.3 Treatment Options

Treatment of most RH-TRU waste will be required to achieve compliance with the WIPP WAC. Treatment will include a variety of processes, depending on the waste form. DOE's plans for treatment of RH-TRU waste are being developed in cooperation with the generator sites and their regulators. Three treatment options were considered. One option contains the elements necessary to meet the WIPP WAC. A second option is to establish a waste form that is less likely to generate gas during decomposition in the repository. The third, more thorough, option eliminates the hazardous components of the waste, making it compliant with the LDRs specified in 40 CFR 268.

5.3.1 Treat to meet the WIPP WAC.

The RH-TRU waste requiring treatment at most sites is heterogeneous solid waste; therefore, treatment to the WIPP WAC will primarily involve basic repackaging operations (open, dump, sort, repack, characterize, and certify). The RH-TRU waste at some sites is in the form of liquid or sludge and will require special treatment such as evaporation/solidification.

5.3.2 Treat to reduce gas generation.

Reduced gas generation during decomposition of RH-TRU wastes emplaced in the repository could be accomplished with a process such as shred and grout and with the use of new waste payload container constructed of a special non-corroding material.

5.3.3 Treat to meet Land Disposal Restrictions (LDRs).

In order to meet LDR requirements, the waste may require treatment to eliminate the hazardous components of the waste. Potential treatment processes include vitrification or other process (e.g., a combination of incineration, neutralization, deactivation, and shredding).

5.4 Privatization Considerations

DOE is currently evaluating the potential schedule improvements and cost reductions that may be achieved by contracting with a private-sector company for the treatment of RH-TRU waste. Privatizing treatment of TRU wastes is estimated to result in greater throughput capabilities and improve the potential shipping schedule for RH-TRU waste to WIPP. For example, ORNL estimates that, through privatization, RH-TRU wastes could be treated and available for shipment to WIPP in 2002 as opposed to 2012, when shipments are currently scheduled to begin. INEL is also considering privatization options and has recently completed a study on the use of privatization to treat CH-TRU waste.

By January 1997, studies being performed by ORNL will be complete so that a decision can be made whether to proceed with privatization or utilize government facilities for treatment of RH-TRU wastes. If DOE decides not to use a private contractor, a treatment facility at ORNL would be required in order to meet near-term objectives of shipping waste to WIPP by 2002; facilities at both ORNL and Hanford are needed for long-term, sustained throughput at WIPP.

6.0 TRANSPORTATION AND PACKAGING

6.1 Requirements and Limitations

This assessment uses the terms "packaging" and "package" as defined in the NRC regulations governing the transportation of radioactive materials (10 CFR 71.4). Pursuant to these regulations, "packaging" is defined as:

the assembly of components necessary to ensure compliance with the packaging requirements of this part. ...The vehicle, tie-down system and auxiliary equipment may be designated as part of the packaging.

A "package" is defined as:

the *packaging together with its radioactive contents* as presented for transport (emphasis added).

In the following sections, vehicle tie-downs and auxiliary equipment are included as part of the packaging. In addition, the term "payload container" is used in this assessment to mean the vessel in which the waste itself is placed.

Shipping and packaging must meet all the requirements of federal laws as well as commitments made to the state and local governments by DOE. These requirements include:

- those affecting the packaging and its design,
- those that impact the waste form for shipping and transportation, those specified by approved permits or agreements, and
- those imposed on transportation.

All RH-TRU waste payload containers (e.g., 3.8 liter [1-gallon] can, 208-liter [55-gallon] drum, shielded drums, or some new configuration) must meet the structural requirements and design conditions set by the Department of Transportation (DOT) for Type A packaging. Payload containers are then either placed in another Type A packaging, such as a canister (design basis) and then placed in NRC-Type B packaging, or are placed directly in the NRC-Type B packaging. NRC-certified Type B packaging could be a road cask, such as the RH-72B (design basis), or a TRUPACT-II. Appendices E and F contain detailed information on packaging configurations, including drawings of several types of containers.

6.2 Packaging Configurations

For the purpose of this assessment, several different packaging options are considered. These options are grouped into four basic configurations, as shown in Table 6-1. All configurations were evaluated except unshielded payload containers in unshielded packaging. This configuration is not applicable because at least one of the containers must be shielded to reduce surface dose rates to meet requirements for transportation handling. Type B Packaging could be used to transport large canisters, small canisters, drums, 3.8 liter (1-gallon) cans, or a new payload container configuration. To meet all current packaging and transportation system requirements, packaging must be transportable by truck.

Table 6-1. Packaging Configurations

NRC-CERTIFIED TYPE B PACKAGING	DOT-CERTIFIED TYPE A WASTE PACKAGING	
	SHIELDED PAYLOAD CONTAINER	UNSHIELDED PAYLOAD CONTAINER
Shielded Packaging (e.g., RH-72B)	Evaluated	Evaluated
Unshielded Packaging (e.g., TRUPACT-II)	Evaluated	Not Applicable

6.2.1 Canister

The current design basis design is the RH-72B cask. Its payload is a vented canister that is 3.1 meters (10 feet) long by 0.66 meters (2.25 feet) in diameter. The vented canister weighs 998 kg (2,200 lbs) and has a maximum payload of approximately 2,631 kg (5,800 lbs)⁶, which is about 0.89 m³ (31 ft³) of waste. This canister has a relatively high fabrication cost (\$12,000 - \$14,000 each), and the canister lid must be attached with a certified welding process.

6.2.2 Shielded Packaging

Various types of Type B shielded packaging exist which are composed of or lined with materials designed to attenuate the radioactive source in order to reduce the surface dose rate of the packaging. NRC-certified Type B packagings are available that can hold a variety of unshielded DOT Type A payload containers. The NRC Certificates of Compliance for some shielded packaging may need to be modified in order to carry some RH-TRU waste.

Another option is to design entirely new packaging to handle lower dose rate containers. This would result in significant cost savings in shielding, and the reduced weight of the shielding would allow the design of a less expensive and greater payload cask than the RH-72B. This option is feasible because the majority of RH-TRU waste in the system is less than 100 rem/hr, whereas the RH-72B was designed to hold canisters with surface dose rates up to 1,000 rem/hr. High-dose-rate RH-TRU waste could be scheduled for shipment late in the operational life of the WIPP, allowing for the decay of some isotopes, which could result in packaging with less shielding being required. This option would also allow more time for WIPP to procure additional RH-72B casks or an alternative cask.

⁶The canister plus payload must be less than or equal to 3,629 kg (8,000 lbs).

6.2.3 Unshielded Packaging (Shielded payload containers in TRUPACT-II)

This option uses shielded payload containers to contain RH-TRU waste, bringing the surface dose rate of the package to less than 200 mrem/hr. The payload containers would then be operationally handled as CH-TRU waste and could be shipped in the TRUPACT-II and emplaced in the WIPP in the same manner as CH-TRU waste. The types of shielding being considered include steel, depleted uranium, and concrete.

6.2.4 New Design Unshielded Packaging (TRUPACT-II type packaging)

A new packaging design is being considered that is essentially the same as the TRUPACT-II, but only half the height. It would use the same inner and outer containment vessel (ICV/OCV) lids as the TRUPACT-II, but the ICV and OCV bodies would be shortened to a one-drum-high rather than two-drum-high configuration. The current tie-down/trailer interface would be retained, and all of the same TRUPACT-II handling equipment would be used. Because of the lighter weight of the new packaging design, it could accommodate a payload of 4,536 kg (10,000 lbs) compared to the maximum payload for the TRUPACT-II of 3,295 kg (7,265 lbs). This new packaging could be used to ship RH-TRU waste in shielded payload containers with surface dose rates less than 200 mrem/hr. Due to the similarities between this new packaging and the TRUPACT-II, it is expected that the new container could be NRC-certified with minimum effort.

6.3 Transportation Configurations

Truck and rail are the two general methods for transporting RH-TRU waste to the WIPP. Transportation configurations include the following:

- 100% truck,
- Utilization of rail to the maximum extent possible, combined with the use of trucks from sites where rail is not feasible,
- Rail shipments from large-quantity generators and truck shipments from small-quantity generators,
- Truck shipments until regional treatment facilities become operational, then utilizing rail shipments.

Cost, flexibility, and risk are among the criteria used to evaluate these transportation configurations. All of the above transportation configurations are capable of meeting the work-off-plan requirements, assuming adequate funding is available. All modes are

technically viable and can meet regulatory requirements. Some of the generator sites do not currently have access to rail, so the system must maintain some truck capability.

6.4 Actions Required

Near-Term Actions

- Start waste shipments by truck from sites.
- Continue certification of the RH-72B packaging.
- Make decision by the end of fiscal year 1996 whether to develop alternate packaging in addition to the RH-72B.

Long-Term Actions

- Continue evaluation of system packaging needs.
- Reevaluate shipments by rail when treatment facilities at Hanford and ORNL are operational.

7.0 DISPOSAL

7.1 Requirements and Limitations

The RH-TRU waste disposal system at the WIPP must comply with a number of requirements designed to ensure safety and efficiency. The following list is a summary of the major requirements, which are discussed in greater detail in Section 1.2 of this document.

1. The authorized capacity for disposal of RH-TRU waste is 7,080 m³ (250,000 ft³). This is equivalent to 7,955 canisters, assuming an internal volume of 0.89 m³ per canister.
2. Total RH-TRU waste activity is limited to 5.1 million curies, with a maximum activity (averaged over the volume of a canister) not to exceed 23 curies per liter.
3. Up to 5% of the RH-TRU waste emplaced at the WIPP may have surface dose rates between 100 and 1,000 rem/hr. The remainder of the waste must have surface dose rates less than 100 rem/hr.

4. The disposal canister specifications and waste form requirements must meet the current WIPP WAC.

The design basis disposal system, which is based on the above requirements, has a number of operational and design limitations that must be considered for RH-TRU disposal at WIPP, as shown in the following list.

1. The design basis emplacement configuration is to emplace RH-TRU waste in horizontal boreholes drilled into the walls of the disposal rooms. This must occur before CH-TRU waste is placed in the room in order to provide sufficient space to operate the equipment needed to drill the boreholes and emplace the waste. Once CH-TRU waste drums are placed into a room, the space that would have been available for RH-TRU waste emplacement becomes inaccessible to remote-handling equipment. If sufficient RH-TRU waste is not received at WIPP in time to be emplaced prior to the disposal of CH-TRU waste in a room, the future disposal of RH-TRU waste in that room will be limited, further reducing the capacity of WIPP for RH-TRU waste disposal.
2. Given the limited physical capacity inherent in the use of 10-foot long canisters, with 8-foot centers on disposal, and the current disposal room and access drift dimensions, approximately 70% of the allowable RH-TRU waste inventory could be disposed of at the WIPP, which is less than the authorized limit.
3. Operation of the disposal system is complicated. Emplacement of each canister requires 12 major steps and uses 14 pieces of equipment. Three 8-hour shifts are required to emplace two canisters, excluding any delays. The heavy reliance on specialized emplacement equipment creates many opportunities for system failure, which could result in the interruption of RH-TRU waste disposal until the failed component can be fixed.
4. Significant restrictions were imposed on the facility design that are no longer applicable, but have not yet been eliminated. The restrictions were based on planned disposal tests using Defense High Level Waste, but the tests have since been canceled.
5. Before the RH-TRU waste handling system can be operated, a number of major deficiencies must be addressed. For example, repairs, upgrades, or replacement of equipment are needed in the Hot Cell complex, Waste Handling Building, and on underground emplacement equipment. The necessary repairs and procurements are estimated to take approximately three years to complete and will cost over \$3 million.

7.2 Disposal Configurations

Alternatives to the design basis RH-TRU waste disposal system (RH-TRU canisters in horizontal boreholes) were generated using different emplacement configuration options and waste package options. The five emplacement configuration options developed are as follows:

1. **Horizontal Boreholes.** The current design basis disposal configuration uses horizontal boreholes that are drilled in the walls or ribs of the disposal rooms and drifts. RH-TRU waste canisters are pushed into the boreholes and closed off with a shield plug. Although horizontal boreholes cannot be closer than 8-foot centers, they can be deeper, accepting multiple canisters.
2. **CH Stack.** RH-TRU waste could be emplaced in the waste stack (in shielded payload containers) in the same configuration that applies to other CH-TRU waste.
3. **Vertical Boreholes.** Boreholes would be drilled in the floors of the disposal areas soon after the areas are mined. RH-TRU waste would be lowered into the boreholes and covered (backfilled) with salt. After the boreholes are filled, CH-TRU waste would be stacked over the boreholes. Vertical boreholes include holes drilled diagonally.
4. **Trenches.** Slots or pits would be mined in the floor of the disposal areas. The RH-TRU waste packages would be laid into these trenches and covered with salt. After an area is backfilled, CH-TRU waste would be stacked on top.
5. **New Mining.** Disposal areas specifically designed to support RH-TRU waste disposal would be mined. These areas would be in addition to the disposal areas (rooms and drifts) currently planned for CH-TRU waste disposal. The new areas could be on a different horizon or in panels or alcoves mined out of the pillars in the disposal areas.

The four waste-packaging options are briefly summarized below but are discussed in further detail in Section 6.2 and Appendix E.

1. **Canister.** This is the design basis waste payload container. Canisters would be shipped in the RH-72B cask.
2. **Shielded Packaging.** This option involves waste packaging made of materials designed to reduce the surface dose rate to 200 mrem/hr or less, measured from the outside surface of the waste package. Operational payload containers must be handled remotely.

3. **Unshielded Packaging.** This option uses shielded payload containers to contain RH-TRU waste which would bring the surface dose rate of the payload containers to less than 200 mrem/hr so that they can be shipped in unshielded packaging such as the TRUPACT-II. Operationally, the payload containers could be handled similar to CH-TRU waste containers.
4. **New Unshielded Packaging.** A new packaging design is being considered that is essentially the same as the TRUPACT-II, but only half the height. The payload containers are shielded and could be handled similar to those for CH-TRU waste.

The five disposal configurations and four waste packaging options were combined to form 20 emplacement and package options, which are summarized in Table 7-1. Of these options, four were immediately rejected because they provided no improvement over the design basis waste handling process. A detailed description of the process used to evaluate and rank the 16 remaining options is contained in Appendix F.

7.3 Top-Ranked Disposal Options

The 16 disposal options shown in Figure 7-1 were ranked using an analytic hierarchy process. The weighted criteria used in the evaluation were (1) environmental, safety, and health risk; (2) operational impact; (3) technical viability; and (4) cost. The top seven options were then evaluated under a pairwise comparison process (see Appendix F) that confirmed the outcome of the rankings. The following paragraphs briefly summarize the advantages and disadvantages of the seven top-ranked options in the order in which they were ranked. Appendix F provides additional information of these configurations.

Table 7-1. Emplacement and Package Options

WASTE PACKAGE EMPLACED		RECEIVED WASTE PACKAGE			
		A	B	C	D
		Shielded Package (CH)	Unshielded Package	Canister	New
1	CH STACK	X	X	X	X
2	VERTICAL BOREHOLES	Rejected	X	X	X
3	HORIZONTAL BOREHOLES	Rejected	X	X	X
4	TRENCHES	Rejected	X	X	X
5	NEW MINING (ALCOVES, PANELS, HORIZON)	Rejected	X	X	X

7.3.1 A-1. Shielded Package Emplaced in CH-TRU Waste Stack

This option involves shielded payload containers that would be handled in the same manner as CH-TRU waste containers. This option has many advantages: it improves disposal room stability, has fewer support system requirements and fewer maintenance requirements, increases WIPP's ability to process CH- and RH-TRU waste, uses proven technology, is less costly than the design basis, and could potentially increase the facility's ability to prevent or mitigate the consequences of abnormal events that may impact the public or environment. This option is discussed in greater detail in Section 8.0 of Appendix F.

7.3.2 B-3. Unshielded Package Emplaced in Horizontal Boreholes

This option uses remote-handled, unshielded payload containers that are placed in horizontal boreholes in the disposal room walls. The advantages of this option are that it increases WIPP's ability to process CH- and RH-TRU waste, uses packaging that is readily available and easily handled at the generator site, has overall generator site implementation costs that are low with respect to the current design basis, may increase the facility's ability to prevent or mitigate the consequences of abnormal events that could impact the public or the environment, potentially decreases worker radiation exposure,

and may improve WIPP's ability to isolate TRU waste from the accessible environment. However, this option has more maintenance activity requirements, is more costly with respect to maintenance and operations than the design basis system, and may increase the consequences of abnormal events with respect to personnel safety and health. Section 8.0 of Appendix F contains a detailed discussion of this option.

7.3.3 D-3. New Package Emplaced in Horizontal Boreholes

In this option, small, unshielded payload containers would be emplaced in horizontal boreholes in the disposal room walls. This option increases WIPP's ability to process CH- and RH-TRU waste, to prevent or mitigate the consequences of abnormal events that could impact the public or environment, and to improve the disposal system's ability to isolate TRU waste from the accessible environment, and it decreases worker radiation exposure with respect to current design basis projections.

7.3.4 B-2. Unshielded Package Emplaced in Vertical Boreholes

This option places unshielded payload containers in vertical boreholes located in the floors of the disposal areas. Option B-2 increases WIPP's ability to process CH- and RH-TRU waste, uses packaging that is readily available and easily handled at the generator site, has overall generator site implementation costs that are low with respect to the current design basis, may increase the facility's ability to prevent or mitigate the consequences of abnormal events that could impact the public or the environment, and potentially decreases worker radiation exposure. This option has more maintenance activity requirements and is more costly with respect to maintenance and operations than the design basis system.

7.3.5 C-3. Canister Emplaced in Horizontal Boreholes

Option C-3 represents the design basis disposal system configuration. It is described in detail in Section 4.0 of Appendix F.

7.3.6 D-1. New Package Emplaced in CH-TRU Waste Stack

In this option, small, shielded payload containers are handled similarly to CH-TRU waste containers. This option improves disposal room stability, has fewer support system and maintenance requirements, is less costly than the current design basis with respect to modifications and operations, may increase the ability of the facility to prevent or mitigate the consequences of abnormal events that could impact the public or environment, and may improve the ability to adequately isolate TRU wastes from the accessible environment. However, this option uses packaging that is not readily available nor easily handled by the generator sites, has high overall generator site implementation costs

compared to the current design basis system, and may increase worker radiation exposure with respect to current design basis projections.

7.3.7 B-5. Unshielded Package Emplaced in New Mined Area

Option B-5 uses unshielded payload containers that would be emplaced in a disposal room, area of the mine or level of the mine specially designed and dedicated for RH-TRU waste disposal. This option improves disposal room stability, increases WIPP's ability to process CH- and RH-TRU waste, uses packaging that is readily available and easily handled at generator sites, has low generator site implementation costs with respect to the current design basis, uses proven technology, and may decrease worker radiation with respect to current design basis projections. However, it also has more support system and maintenance activity requirements, is more costly with respect to modifying the system design basis, and may diminish WIPP's ability to adequately isolate wastes from the accessible environment.

8.0 SYSTEM EVALUATION

The current RH-TRU design basis case and five alternatives were evaluated for Total System Cost, Unit Cost, RH Waste Potentially Removed from Sites, and RH Waste Emplaced at WIPP. The design basis and each alternative were analyzed using a system simulation model that tracks interdependent system parameters. The alternatives analyzed focused on long-term sustained throughput operations. Changes to the RH disposal configuration could be made anytime in the operational life. Prior to implementation of these changes, the appropriate documentation and permits would need to be revised. The design basis and each of the alternatives evaluated are briefly described in this section and more fully discussed in the attached appendices. The results are summarized in Section 8.8 and Table 8-1 of this document. By analyzing the impact that each postulated alternative may have on the safety, cost, schedule, and waste volume throughput of the RH-TRU system, desirable aspects of RH-TRU waste management can be identified and incorporated into DOE's RH-TRU waste management plans in order to optimize the national RH-TRU waste system. The modeled cases in this study were chosen to encompass the spectrum of alternatives. A table showing a summary of the key features of each alternative and the design basis is contained in Section 8.7. More detailed information is found in Appendix D.

8.1 Design Basis

The design basis is developed from the WTWBIR (DOE, 1995b) and from site-specific data for RH-TRU waste management as documented in site logic diagrams, Activity Data Sheets, and other relevant sources. Each site that currently stores or generates RH-TRU waste is assumed to use existing or planned facilities for retrieving,

repackaging, characterizing, certifying, and loading RH-TRU waste shipments. At the large-quantity sites, most of the required facilities were assumed to be located permanently on-site near the waste storage or generating facilities. Two new major treatment facilities are included in the design basis plan—one at Hanford and one at ORNL. Small-quantity sites will be able to ship RH-TRU waste to WIPP if documented acceptable knowledge exists or if the waste can be processed with existing site facilities. Otherwise, mobile capabilities may be the most practical means of processing small-quantity site RH-TRU waste. The design basis configuration does not currently include mobile capabilities.

All shipments will be in RH-72B casks, and all RH-TRU waste will be emplaced at WIPP using existing equipment and procedures that rely on horizontal emplacement in the walls on 8-foot centers. This WIPP emplacement configuration limits the total RH-TRU waste volume that can be disposed of to 4,780 m³, or 168,785 ft³ (5,371 boreholes), and limits the RH-TRU waste throughput rate to 350 canisters per year. RH-TRU disposal operations will begin in the year 2002, four years after CH waste emplacement begins. During this 4-year period, approximately 500 m³ (17,655 ft³) of RH-TRU waste disposal capacity will become unavailable as a result of CH emplacement in the first few rooms. Therefore, the total RH-TRU capacity at WIPP using the design basis scenario is about 4,280 m³ (151,130 ft³) which, based on the preliminary work-off plan, would be reached before the year 2022.

Since the current design limits the amount of available space in the facility for the RH-72B canisters, RH disposal costs are terminated at the year 2022. Thus, the total system costs appear to be low for this scenario, but the volume of RH waste disposed is also low; therefore, the cost per unit of waste disposed is higher than any of the alternatives evaluated.

8.2 Alternative 1

The first alternative uses shielded payload containers in addition to unshielded canisters for disposing of RH-TRU waste. The amount of RH-TRU waste that can be packaged in shielded drums is limited by the dose rate of the waste materials. About 30% of RH-TRU waste can be packaged in shielded payload containers and remain below the 200-mrem/hr surface-dose-rate limit on CH packages. The balance of the RH-TRU waste that cannot be packaged in shielded payload containers is assumed to be handled as in the design basis. The shielded payload containers would be placed in the CH stacks, avoiding the special WIPP operations problems associated with the placement of RH-TRU canisters in the walls before beginning CH emplacement in the rooms.

This alternative uses all of the available wall space for RH-TRU canisters at WIPP (4,280 m³/151,130 ft³) and, in addition, could place about 10,000 m³ (353,107 ft³) of waste in shielded payload containers in the underground CH-TRU storage area. Therefore, Alternative 1 can dispose of 14,225 m³ (502,295 ft³) of the generator sites' RH-TRU waste stored and projected through the year 2033.

Although the total system cost for this alternative is more than the design basis scenario, the cost per unit of disposed waste is less than half of the design basis unit cost, and it could potentially result in three times as much RH-TRU waste being removed from the generator sites.

8.3 Alternative 2

This alternative involves the use of regional treatment facilities, treatment of RH-TRU waste to reduce gas generation, and utilizing new DOT Type-A packaging that meet the requirements for reduced gas generation. Treatment to reduce gas generation includes a shred and grout process that is expected to reduce the rate at which the waste will decompose in the repository, thereby reducing the rate at which gas is generated and subsequently minimizing gas buildup. The new DOT Type-A waste packaging is assumed to be constructed of a non-corroding or special material that reduces gas generation in the repository. This scenario results in RH-TRU disposal being delayed until 2010, when the regional treatment facilities are assumed to become operational.

The RH-72B canister-cask system is replaced with an RH-TRU payload container that makes handling easier at WIPP and potentially at some of the RH-TRU generator/storage sites. The throughput for the new system is assumed to be 50% faster than the RH-72B system, based on system simulation studies. Even more importantly, the new payload container design allows for greater volume capacity at WIPP. This is because more payload containers can be emplaced in each borehole; more boreholes, of varying depths, can be provided; and most of the horizontal boreholes are assumed to accommodate a greater volume of waste than the 0.89 m³ (31.43 ft³) of a single RH-72B canister. Additionally, if the new, smaller waste packages were used, the emplacement machine could be reduced in length and could then be used to emplace waste in the walls of the narrow access drifts.

The total system cost for this alternative is nearly as low as that for the design basis plan, but the unit cost is high compared to the other alternatives.

8.4 Alternative 3

The third alternative involves special treatment of RH-TRU waste to meet LDR standards. The treatment process is assumed to be vitrification or some other process having a similar cost (e.g., a combination of incineration, neutralization, deactivation, and shredding). After treatment, the waste is packaged for shipment and disposal. Alternative 3 uses a combination of truck and rail transportation, and includes the use of a new RH-TRU canister and cask design and emplacement procedure. The treatment plant size was assumed to be the same as in Alternative 2. As with Alternative 2, this scenario results in delaying shipments of RH-TRU waste to WIPP for disposal until 2010, when the treatment facilities become operational.

This alternative yields a waste work-off schedule that is similar to Alternative 2, but the total system and unit costs are higher. The principal cost difference between Alternative 3 and other options is the expense associated with LDR treatment.

8.5 Alternative 4

This alternative is intended to increase the total volume of RH-TRU waste disposed of to achieve the 7,080 m³ (250,000 ft³) authorized limit. All assumptions are similar to the design basis and Alternative 1 except the payload container configuration. RH-TRU waste is processed at each site to meet the WIPP WAC and shipped by truck to WIPP. However, in this scenario, the waste is packaged in either the new unshielded RH-TRU packaging or in shielded payload containers. Waste can be packaged and shipped early (i.e., in 2002), and a higher RH-TRU waste throughput rate can be achieved at WIPP by replacing the RH-72B system with the new RH-TRU packaging system. The analysis of this alternative used shielded drums assumed to hold .03 m³ (1.06 ft³) of waste, based on vendor information. However, other shielded payload containers could be used as well.

Alternative 4 yields a greater quantity of RH waste being removed from the sites and a lower unit cost of waste disposed of than any of the other alternatives. The total system cost for this alternative is the second highest. A large part of the total cost is associated with the shielded payload containers and their shipping and disposal.

8.6 Alternative 5

The alternative included in this evaluation is similar to Alternative 3 in that it includes LDR treatment of the waste at regional plants, but in this scenario 20% of the waste is assumed to be processed at the sites, packaged in either shielded payload containers or the new design packaging, and shipped directly to WIPP. This assumption is based on

the fact that some of the waste now in storage and soon to be generated is non-mixed waste that could be disposed of without LDR treatment.⁷ Furthermore, some of the waste can be sorted at the sites while it is being prepared for shipment to the regional treatment plants, and the sorting can generate additional non-mixed waste for direct shipment to WIPP. The remainder of the waste would be shipped to regional plants, LDR-treated, and then shipped to WIPP.

This alternatives yields a waste shipping schedule that is nearly identical to Alternative 4. The total system cost for this alternative is the highest of all those evaluated, but the unit cost is still relatively low. The largest component of the cost is that associated with the large regional LDR treatment facilities.

8.7 Summary of Alternatives

Since the current design can accommodate the near-term receipt goal, the design basis and alternatives evaluated are all focused on long-term, sustained throughput operations. The decision on which configuration (or combination of configurations) will be implemented is currently scheduled to be made late in fiscal year 1996. Table 8-1 contains a summary of the key features of the design basis and alternatives, including the total system and per-unit costs.

8.8 Results of System Evaluation

Each of the alternatives offer an improvement to RH-TRU waste management over the design basis, since each alternative provides greater assurance of achieving the authorized limit of 7,080 m³ (250,000 ft³). However, there is a large uncertainty associated with the cost estimates determined in this evaluation. However, because cost comparisons can be both useful and informative, these are summarized below and are more fully discussed in Appendix D. Since Alternatives 1 and 4 have the lowest unit costs, the decision to use shielded payload containers to enhance DOE's RH-TRU waste management plan seems to be appropriate. Cost alone should not be the deciding factor because many of the alternatives were very closely ranked.

In addition to cost, another uncertainty to be considered is the ability of WIPP to accommodate the new RH-TRU payload container in the manner assumed in the system simulation. The availability of sufficient wall space or of another emplacement method such as a separate room must be verified through analysis or approved by the regulators. The assumption that shielded payload containers can be managed at WIPP

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⁷The WIPP has filed a No-Migration Variance Petition with the EPA. If granted, treatment to LDR would not be required for waste disposed of at WIPP.

with minimal environmental, safety, and health impact needs further site-specific evaluation before shielded payload containers are selected as an option.

This analysis suggests that a better alternative might be created by improving the design and payload of the shielded payload container. If each shielded container could contain more than either the 0.208 m³ (7.34 ft³) or 0.05 m³ (1.77 ft³) as assumed for the current analysis, a lower cost and more efficient RH-TRU waste management option might be created. By initiating RH-TRU waste disposal using the 0.03 m³ (1.06 ft³) shielded payload container described in Alternative 4 and later (about 2010) replacing it with a larger-volume payload container, (e.g., an 83-gallon container that shields either 0.208 m³ (7.34 ft³) or 0.05 m³ (1.77 ft³) of RH-TRU waste, total system costs could be lowered and the total amount of RH-TRU waste removed from the generator sites could be increased while maintaining RH-TRU emplacement operations continuously from 2002 to 2033. The use of larger-volume shielded payload containers would reduce both the number of the drums needed and the number of shipments made, decreasing both cost and risk.

Table 8-1. Summary of Design Basis and Alternative System Analyses

FACTORS	Design Basis	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Facility Configuration	Decentral	Decentral	Regional	Regional	Decentral	Decentral/Regional
Treatment Options	WIPP WAC	WIPP WAC	Reduced Gas Generation	LDR	WIPP WAC	WIPP WAC and LDR
Transport Option	Truck	Truck	Truck + Rail	Truck + Rail	Truck	Truck + Rail
Packaging/Disposal Option	RH-72B	RH-72B and Shielded Payload Container	New Design Packaging	New Design Packaging	Shielded Payload Container and New Design Packaging	Shielded Payload Container and New Design Packaging
EVALUATION RESULTS						
RH Waste Potentially Removed from Sites ¹ (m ³)	4,280	14,225	7,080	7,080	16,840	16,474
RH Waste Emplaced at WIPP ² (m ³)	4,280	4,280	7,080	7,080	7,080	7,080
Total System Cost (Billions)	\$3.54	\$5.31	\$3.82	\$4.35	\$5.41	\$6.33
Unit Cost ³ (Millions)	\$0.83	\$0.37	\$0.53	\$0.60	\$0.32	\$0.38

¹The volume removed includes both RH waste in RH packaging and RH waste in shielded payload containers. Where the volume exceeds 7,080 m³, it is assumed that shielded waste is classified as CH or modification of the State C&C Agreement.

²The volume emplaced includes only waste emplaced as RH-TRU waste. It does not include RH-TRU waste in shielded payload containers because these would be handled in the same manner as CH-TRU waste containers.

³The unit cost is per cubic meter removed from the sites and emplaced at WIPP.

9.0 CONCLUSIONS AND ACTIONS

9.1 Conclusions

As shown in the previous sections, a systematic approach has been taken to address RH-TRU waste management. From the six evaluated elements of this assessment, Inventory and Generation, Storage, Characterization, Treatment, Transportation and Packaging, and Disposal, several basic conclusions may be reached. These are:

- Stored and projected RH-TRU waste inventories will exceed the authorized disposal capacity of WIPP.
- Waste acceptance requirements specific for RH-TRU waste at WIPP have not been developed.
- Current NDE and NDA equipment will be able to characterize a limited amount of RH-TRU wastes, but new or improved capabilities are required to characterize all RH-TRU waste.
- Modifications to equipment or facilities will be needed at some generator sites in order to load the design basis RH-TRU canisters.
- The design basis disposal configuration of placing RH-TRU waste canisters in horizontal boreholes does not provide sufficient capacity for the RH-TRU waste volume authorized.

9.2 Recommended Actions

To accommodate the above conclusions, recommended actions are divided into two parts. In accordance with the two basic intents of this assessment: the first set of actions are near-term actions to ensure initial shipment of RH-TRU waste to WIPP, and the second set of actions are long-term actions to allow sustained shipments over the disposal period.

9.2.1 Near-term Actions

The near-term goal is to begin RH-TRU waste receipt at WIPP in the year 2002. Beginning disposal of RH-TRU waste at WIPP four years after CH-TRU disposal operations begin will result in the permanent loss of some RH-TRU storage space. By current estimates, three years will be required to bring the WIPP RH-TRU facilities and equipment into a state of operational readiness. By this time the RH-72B cask will be certified and available for shipment of RH-TRU wastes. The WIPP WAC for RH-TRU waste will be updated and the sites will have developed the necessary characterization and certification programs to package RH-TRU waste for transport and disposal. Regulatory requirements at the WIPP site will be completed by October of 1997. Initial receipt of RH-TRU waste through the existing facilities at WIPP in accordance with current program procedures and descriptions could therefore proceed in the year 2002 without the loss of additional RH-TRU storage space.

The actions necessary to accomplish this near-term goal are:

Clarify the waste acceptance and characterization requirements for RH-TRU waste.

Current RH-TRU waste acceptance requirements are derived from the same sources as the CH-TRU waste acceptance requirements. Because of the limited volume of RH-TRU waste and the risk involved in RH operations, these requirements are extremely conservative within the current regulatory framework. Specific requirements should allow characterization and certification of RH-TRU to proceed in accordance with an established QAPP (Quality Assurance Program Plan) and site-specific QAPjPs (Quality Assurance Project Plans). The National TRU Program must therefore develop RH-TRU-specific QAPP requirements and data quality objectives for the RH-TRU Waste Program that more fully incorporate ALARA principles and the risk/benefit.

Complete the NRC certification of the RH-72B cask.

Since the RH-72B design process is complete and the certification process is currently on-going, final certification should be completed. The RH-72B cask is the design basis transportation configuration for transporting the RH-TRU canisters of waste for disposal at WIPP. Also, use of the RH-72B cask would require no changes to current permit applications, the WIPP Safety Analysis Report, or WIPP National Environmental Policy Act documents. The RH-72B presents a viable shipment option for RH-TRU waste to WIPP by truck since all sites are accessible by highway.

Modify the TRUPACT-II Certificate of Compliance and other necessary requirement documents to allow shipments of shielded payload containers.

Shielded payload containers offer a potential opportunity to start removing RH-TRU wastes from the generator sites earlier than scheduled in the design basis configuration. The necessary analyses would need to be performed to support the revision of the appropriate documentation, licenses, and permits.

Prepare the WIPP RH-TRU waste facility for receiving RH-TRU waste.

The current design basis configuration for handling RH-TRU waste at WIPP requires use of the RH-72B cask, the RH-TRU Receiving Bay, and the associated handling and emplacement equipment. Prior to receipt of RH-TRU waste, the WIPP facility and ancillary equipment need to be in a state of readiness to implement the design basis waste disposal configuration. An appropriate readiness review would need to be performed.

Begin characterizing and packaging RH-TRU waste at the generator sites for transportation and subsequent disposal at WIPP.

Currently, 30% of the RH-TRU waste inventory is estimated to be characterizable with available NDE and NDA technology. Sixteen canisters of RH-TRU waste are currently packaged, but not yet certified to meet the present WIPP WAC. Waste considered to be easily characterized—primarily that representing heterogeneous or debris-type waste and some homogeneous sludges (e.g., ORNL sludges)—should be characterized, packaged, and certified for transport and disposal at WIPP.

The first two sites to ship RH-TRU waste to WIPP will be LANL and ORNL. These two sites have well-established RH-TRU management programs and have characterizable waste. Both LANL and ORNL have facilities that can be made available to characterize and subsequently package RH-TRU waste. Each of these sites should develop a program for RH-TRU waste characterization in accordance with their approved site-specific QAPjPs.

Complete privatization decision by ORNL in fiscal year 1997.

The decision as to whether to use private or government facilities to treat wastes at ORNL and possibly other facilities will affect the time frame for shipments of RH-TRU waste to WIPP. If privatization is selected, RH-TRU wastes may be

treated and available for shipment to WIPP in 2002 whereas, with the use of government facilities, shipments are not expected to begin until 2012.

Confirm design basis configuration for disposal and packaging/transportation for initial waste receipt.

Making this decision as soon as possible will provide the time necessary for any required modifications to ensure receipt of RH-TRU waste at WIPP in fiscal year 2002. Currently this decision is scheduled to be completed by the end of FY 1997.

9.2.2 Long-term Actions

The long-term goal is to sustain RH-TRU waste receipt and throughput at WIPP throughout its operational life. As stated earlier, beginning disposal of RH-TRU waste at WIPP four years after CH-TRU disposal operations begin will result in the permanent loss of some RH-TRU storage space. The inability to sustain throughput during the operational life of WIPP will further erode the available RH-TRU storage space. Therefore, to optimize the use of available space, receipt and throughput at WIPP must be maintained at a sustained level.

The actions necessary to accomplish this long-term goal are:

Identify and implement selected packaging/disposal alternatives.

Several alternatives to the design basis configuration for packaging and transportation offer opportunities to package and remove more of the stored and projected RH-TRU waste from the generator sites than is currently predicted with the design basis system. The use of the RH-72B in conjunction with a ten-foot canister will accommodate only a portion of RH-TRU waste for disposal at WIPP. In addition, the current ten-foot canister requires a rather sizeable area for loading and closure, which some of the generator sites do not currently have. Constructing individual facilities at each generator site for loading these canisters and the RH-72B would be costly. Alternatives offer benefits such as fewer shipments, reduced risks and increased volumes of waste emplaced. As discussed within the body of this document, one alternative would be to use shielded payload containers, which could be handled in a manner similar to the CH-TRU waste containers. These shielded payload containers could be shipped using the existing TRUPACT-II fleet. In addition, RH-TRU payload containers could be modified (i.e., shorter canisters), which may lead to design modifications in the

shipping packaging and/or the emplacement equipment. These modifications could result in greater use of the accessible disposal area at the WIPP.

Other alternatives combine shielded payload containers and new unshielded packaging similar to the TRUPACT-II. The new designs would have greater payloads than the TRUPACT-II, which would result in better volumetric efficiencies and a greater volume of RH-TRU waste being removed from the sites and disposed of at WIPP. These packaging designs could also result in fewer shipments being made to WIPP, reducing transportation and handling risks.

Rail transport from the larger sites, such as Hanford or ORNL, or the use of regionalized facilities could also be implemented.

Decisions concerning the selected alternatives will be made prior to September 1996 in accordance with the WIPP Disposal Decision Plan.

Enhance characterization technologies and capabilities, and/or facilities for NDE and NDA.

Fixed facilities, such as specific site facilities or regionalized facilities for treatment and/or characterization, and possibly mobile characterization capabilities for RH-TRU waste characterization must be planned and developed.

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EXHIBIT A

**Comparison of CH-TRU and RH-TRU Characterization
Methodologies for WIPP WAC, Revision 4
with Modified RH-TRU Requirements/Criteria**

EXHIBIT A
Comparison of CH-TRU and RH-TRU Characterization
Methodologies for WIPP WAC, Revision 4
with
Modified RH-TRU Requirements/Criteria

DOE/CAO-95-1143, Vol. 1

SUMMARY OF WAC LIMITING PARAMETERS FOR RH-TRU WASTE		COMPLIANCE METHODOLOGY*		
CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	CH-TRU WASTE	LOWER SURFACE DOSE RATE RH-TRU WASTE	HIGHER SURFACE DOSE RATE RH-TRU WASTE
WASTE CONTAINER REQUIREMENTS/CRITERIA				
Waste Containers 3.2.1	- Containers shall be noncombustible and meet DOT specifications for Type A packaging requirements. - RH-TRU cask requirements limit acceptable containers to a WIPP RH-TRU canister or 3 drums overpacked in a WIPP RH-TRU canister.		Procurement/Administrative Controls Inspection	
Waste Package Size 3.2.2	RH-TRU cask allows only a WIPP RH-TRU canister.		Administrative Controls Inspection	
Waste Package Handling 3.2.3	All WIPP RH-TRU canisters shall be configured with an axial lifting pintle (see 3.2.2 above).		Procurement/Administrative Controls Inspection	
WASTE FORM REQUIREMENTS/CRITERIA				
Immobilization 3.3.1	Waste materials shall be immobilized if >1% by weight is particulate material < 10 microns in diameter, or if >15% by weight is particulate material < 200 microns in diameter.		Process Controls/Knowledge	

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SUMMARY OF WAC LIMITING PARAMETERS FOR RH-TRU WASTE		COMPLIANCE METHODOLOGY*		
CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	CH-TRU WASTE	LOWER SURFACE DOSE RATE RH-TRU WASTE	HIGHER SURFACE DOSE RATE RH-TRU WASTE
Liquids 3.3.2	Only residual liquids; as a guideline, residual liquid in well-drained internal containers to be restricted to approximately 1 volume % of the internal container; aggregate amount of residual liquid < 1 volume % of external container.	RTR (shielded containers, if allowed, will require visual)	RTR with some equipment modification (will require visual, if shielded)	Visual New Technology?
Pyrophoric Materials 3.3.3	No non-radionuclide pyrophorics permitted. Radionuclides in pyrophoric form are limited to <1% by weight in each waste package.	Process Controls/Knowledge Oxidation Process		
Explosives 3.3.4	No explosives (49 CFR Part 173, Subpart C) are permitted.	Procurement/Administrative Controls Process Controls/Knowledge		
Compressed Gases 3.3.4	No compressed gases are permitted.	RTR Visual		Visual New Technology?
TRU Mixed Waste 3.3.5	- TRU wastes shall contain no hazardous wastes unless they exist as co-contaminants with transuranics. - Waste generators must determine if their waste is regulated by RCRA, and meet the requirements in the WIPP RCRA Part A and Part B Permit Applications.	Administrative Controls Process Controls/Knowledge Supplemented with Sampling and Analysis, if necessary		
TRU Mixed Waste 3.3.5 (Con't.)	Generators must document procedures for sampling, analytical protocols, QA/QC guidelines, and other information called for in 40 CFR § 265.13 and 264.13 in a site-specific OAPjP.	Administrative /Document Controls		

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TRU Mixed Waste 3.3.5 (Con't.)	- Characteristic ignitable (D001), corrosive (D002), and reactive (D003) wastes are not acceptable at WIPP. - Sludges shall be analyzed for total VOCs and toxic metals specified in the NMD.	Process Controls/Knowledge Supplemented with Sampling and Analysis, if necessary		Same, but these characteristics may not be demonstrable in a hot cell.
TRU Mixed Waste 3.3.5 (Con't.)	- Any waste container sent to WIPP must meet the two times (2X) the maximum comparability requirement for 5 nonflammable VOCs as specified in the NMD. - Any waste container sent to WIPP must meet the ten times (10X) the average comparability requirement for 3 nonflammable VOCs as specified in the NMD.	Sampling and Analysis		
Specific Activity of Waste 3.3.6	Waste shall be greater than 100 nanocuries of TRU per gram of waste, exclusive of added shielding, rigid liners, and the waste containers, including alpha contaminated wastes handled as TRU under DOE Order 5820.2A.	Nondestructive Assay (NDA) System or Radiochemical Analysis (for solidified waste forms)		New Technology?
Waste Package Weight 3.4.1	Current waste package limits are 8000 lbs per WIPP RH-TRU canister.	Using Calibrated Equipment, in a heavily shielded environment, if necessary Sum of the parts		
Nuclear Criticality (Pu-239 FGE) 3.4.2	Accepted package limits, including two times the error, are: - < 325FGE/WIPP RH-TRU canister	Use Techniques Documented in RH-TRU Cask SARP		New Technology?
Pu-239 Activity 3.4.3	Waste packages shall not exceed 1000 Ci of Pu-239 equivalent activity (PE-Ci).	Calculation Sum of reported specific isotopes		

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Surface Dose Rate 3.4.4	- RH-TRU Canister shall have a surface dose rate of ≤ 1000 rem/hr. - 95% canisters ≤ 100 rem/hr - 5% canisters > 100 rem/hr but ≤ 1000 rem/hr. - Shielded containers are allowed for ALARA purposes only. (CH waste) - Neutron contributions of ≤ 270 mrem/hr. - External dose rates on the loaded RH-TRU Cask shall not exceed 200 mrem/hr surface, or 10 mrem/hr at 2 m.	Use Techniques Documented in RH-TRU Cask SARP		
Surface Contamination 3.4.5	Removable package surface contamination shall not be > 20 dpm/100 cm² alpha, and not > 100 dpm/100 cm² beta/gamma. [NOTE: This is a change to bring the WIPP WAC into compliance with the DOE Radiological Control Manual]	Measured at TRU Waste Generator/Storage Site and Provided in Documentation		
Thermal Power 3.4.6	- Thermal (wattage) limits for individual waste packages, including the error, are contained in the RH-TRU Cask SARP. - RH-TRU Cask design limit is 300 watts.	NRC approved techniques, currently used for CH-TRU should be useable for RH-TRU		New Technology?
Gas Generation 3.4.7	No sealed containers > 1 gallon may be in the waste	Real-time radiography or visual examination.		

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Gas Generation 3.4.7 (Con't.)	Total flammable VOCs are limited to 500 ppm in the headspace gas of waste packages.	Test (on nonradioactive gas samples assumed)		
Gas Generation 3.4.7 (Con't.)	- All chemicals/materials > 1% by weight must be evaluated for compatibility within the waste form and with TRUPACT-II materials of construction. - Trace chemicals (< 1 weight % limit) must total < 5% by weight of the waste in any package. - Chemicals/materials present in concentrations greater than one weight percent, shall conform to the allowable chemicals in each waste material type.	Process Controls/Knowledge		
Gas Generation 3.4.7 (Cont.)	- The maximum number of confinement layers shall be known. - All confinement layers, such as bags, shall be closed only by a twist-and-tape or fold-and-tape method.	Process Controls/Knowledge		
Gas Generation 3.4.7 (Cont.)	Total alpha activity of waste on a container basis	Calculation according to methodology listed in the WIPP QAPP		
Gas Generation 3.4.7 (Cont.)	- Visual characterization of solid waste for 10 waste material categories listed in QAPP. - All WIPP RH-TRU canisters and internal closed drums shipped in RH-TRU Cask shall be vented with one or more filters that meet specifications listed in the RH-TRU Cask SARP.	Visual Examination Visual Examination Administrative Controls		

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CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	CH-TRU WASTE	LOWER SURFACE DOSE RATE RH-TRU WASTE	HIGHER SURFACE DOSE RATE RH-TRU WASTE
DATA PACKAGE REQUIREMENTS/CRITERIA				
Labeling 3.4.8	- A unique identification number shall be permanently attached to the RH-TRU Canister in a conspicuous location using characters at least 2 inches high and should reasonably be expected to last 10 years. - Each package shall have appropriate DOT labels (outside of cask).	Labelling Affixed by TRU Waste Generator/Storage Sites		
Data Package Certification 3.5.1	- A data package with certification shall be transmitted prior to shipment. - Documentation for certification of a WIPP RH-TRU canister for shipment in each RH-TRU Cask shall be submitted. - A hazardous waste manifest shall be utilized for each shipment of TRU mixed waste.	Documentation Provided by TRU Waste Generator/Storage Sites		
OTHER REQUIREMENTS/CRITERIA				

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CRITERION/ REQUIREMENT AND SECTION	LIMITING PARAMETER(S)	CH-TRU WASTE	LOWER SURFACE DOSE RATE RH-TRU WASTE	HIGHER SURFACE DOSE RATE RH-TRU WASTE
Additional Requirements 3.6.1	- Each package shipped shall belong to one of the content codes defined in RH-TRUCON. - Retrievably stored waste that has been unvented shall be vented and aspirated per the RH-TRU Cask SARP. - Payload control procedures outlined in the RH-TRU Cask SARP shall be followed.		Documentation Provided by TRU Waste Generator/Storage Sites	

EXHIBIT B

**Summary of DOE Site Characterization Capabilities
For Remote-Handled Transuranic Waste
(Existing and Planned)**

EXHIBIT B
Summary of DOE Site Characterization Capabilities
For Remote-Handled Transuranic Waste
(Existing and *Planned*)

SITE	RADIOGRAPHY	RADIOASSAY	GAS SAMPLING/CHEMICAL ANALYSIS	VISUAL EXAMINATION
ANL-E	Visual characterization is planned	Segmented gamma scanner consisting of a 4,096 channel plus-height analyzer, germanium detector, and computerized data collection is available in the Alpha-Gamma Hot Cell Facility (AGHCF).	Fission gas analysis and collection system and micro-sampling equipment are available in the AGHCF.	AGHCF - The 11'x32' AGHCF consists of a multicurie hot cell, a small machine shop, a decontamination/repair area, surrounding open areas, and the Electron Beam Laboratory (EBL) which contains a shielded electron microprobe, a glovebox for specimen preparation, a scanning electron microscope, and a scanning Auger microprobe. The cell is capable of handling fuel elements up to 6-ft nominal length, although longer lengths can be accommodated. The AGHCF has been previously used to examine and repackage 30-gallon drums of RH-TRU waste. Building 200 Hot Cell Facility - The complex houses 12 isolated hot cells. Shielding capabilities of the cells for gamma radiation are a minimum of 30 Ci for five cells, 1000 Ci for three cells, 50,000 Ci for one cell, and 1 million Ci of 1 MeV of gamma radiation for the remaining three cells. A system of radio-controlled carts can be remotely operated from outside the shielded areas for access to any of the 12 cells. Small cranes are capable of moving up to 2 tons within the cells. The largest cells, two on each floor, can accommodate specimens up to 11-ft-long.

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SITE	RADIOGRAPHY	RADIOASSAY	GAS SAMPLING/CHEMICAL ANALYSIS	VISUAL EXAMINATION
ANL-W	Irradiated specimens can be examined in the HFEF/North ¹ main cell using neutron radiography techniques. A second neutron radiography station, outside of the argon gas main cell, also enables radiography to be conducted without introducing the unirradiated or irradiated specimens into the HFEF/N main hot cell.	Segmented gamma scanner available in the HFEF. <i>PAN assay for RH wastes planned.</i>	FTIR system installed in the Waste Characterization Area of the HFEF/N ¹ <i>Working in conjunction with the INEL in the development of a portable gas sampling and analysis system.</i>	Hot Fuel Examination Facility/North - This facility comprises two adjacent, shielded hot cells designed for long-term, permanent, remote operations without requiring personnel entry. Much of the in-cell examination equipment for fuel elements is automated or semi-automated. In-cell examinations include detailed viewing and photography, weighing, precision dimensional surveys, precision gamma-ray scanning, electrical eddy-current cladding testing, and fuel element fission-gas puncturing and sampling.
INEL	Real-time radiography for CH TRU waste drums and boxes ¹	PAN assay for 55-gal CH TRU waste drums ¹ <i>Selected site for testing the CTEN Assay system being developed by LANL¹</i>	Prototype headspace gas sampling system, not in use ¹ <i>Portable chemical analysis system for TRU waste drum headspace gas sampling system; installation of an FTIR at-line sampler in the INEL Drum Venting Facility¹</i>	Test Area North Hot Cells and Test Reactor Area Hot Cells may both have potential application for visual characterization and direct sampling of RH TRU wastes.
HANF	RTR for CH TRU waste drums and boxes ¹ <i>Enhanced RTR for RH-TRU</i>	PAN assay for 55-gal CH TRU waste drums ¹ <i>Enhanced assay system for RH-TRU</i>	None	<i>Undetermined facility planned.</i>

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SITE	RADIOGRAPHY	RADIOASSAY	GAS SAMPLING/CHEMICAL ANALYSIS	VISUAL EXAMINATION
LANL	RTR for CH TRU waste	PAN assay for 55-gal CH TRU waste drums; ¹ PAN assay for 1-gal RH TRU waste cans ² <i>CTEN assay for 55- and 83-gallon drums</i>	None	LANL Chemical and Metallurgy Hot Cell Facility - This facility is a complex of 16 cells (6'W x 12'H x 12' or 14'L). Each bank of eight hot cells has a central corridor and hydraulic-actuated doors for isolation of each cell. The central corridor has enough space to easily accommodate 55-gal drums, shielded waste casks, or larger overpacks. The hot cells are designed for 100,000 Ci loading with ⁶⁰ Co. Ample room and flexibility is available to provide space for shielded gloveboxes in the hot cell corridor or as stand-alone systems. There are hot cell penetrations that are straight-through, bent-angle, and cell-to-cell.
ORNL	RTR for CH TRU waste drums and boxes ¹	PAN assay for CH TRU 55-drums; ¹ segmented gamma scanner ¹ <i>Linear accelerator-based PAN system</i>	None	Building 3517 Fission Products Development Laboratory - Building 3517 is a two-story structure with a metal-sided high bay area over the cell bank. The cell roof has removable plugs for access to each cell. The cell bank consists of two rows that consist of 17 cells with overall dimensions of 28.5-ft wide by 89-ft-long by 18-ft-high. The interiors of the hot cells are highly contaminated from past operations. The soil surrounding this structure is also highly contaminated with fission products and requires remediation.

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Summary of DOE Site Characterization Capabilities For Remote-Handled Transuranic Waste (Existing and Planned)

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SITE	RADIOGRAPHY	RADIOASSAY	GAS SAMPLING/CHEMICAL ANALYSIS	VISUAL EXAMINATION
ORNL (contd)				Building 3525 High Radiation-Level Examination Laboratory - Building 3525 is a basic two-story brick building that includes a shielded-cell complex which has a working area of 950 ft² shielded for high-gamma activity. The building structure outside the hot cells is completely protected by an automatic wet-pipe sprinkler system, while the hot cells are equipped with heat detectors. Items up to 4 x 4 x 6 ft in size and weighing up to 10 tons may be transferred through a shielded airtight door system. Structural provisions have been made for installation of heavy-duty manipulation equipment if needed.
ORNL (contd)				Building 7860 (Hydrofracture Facility) - Building 7860 is a L-shaped single-story structure with overall dimensions of 56' x 79.5'. Building 7860 was formerly used to inject liquid waste and grout into underground shale formations, a disposal technique that is no longer allowable. Therefore, the building is no longer in use. The liquid waste had a radionuclide concentration of one curie per gallon consisting of primarily ¹³⁷Cs and ⁹⁰Sr, which are the primary cell contaminants. The Tennessee Department of Health and Environment will not permit any further use of this disposal technique; therefore Building 7860 is no longer in use. The liquid waste had a radionuclide concentration of one curie per gallon consisting of primarily ¹³⁷Cs and ⁹⁰Sr. Hence, the equipment within the hot cells, and probably the cells themselves, are contaminated with these and other radionuclides.

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SITE	RADIOGRAPHY	RADIOASSAY	GAS SAMPLING/CHEMICAL ANALYSIS	VISUAL EXAMINATION
ORNL (contd.)				Building 7930 (Thorium-Uranium Recycle Facility) - The second floor of this three-story building provides space for sampling of radioactive materials, a development laboratory, a shop for handling slightly contaminated material, a maintenance area, and mechanical and electrical service equipment rooms. The shielded cells have a gross floor area of 5,740 ft². The bulk of the shielding is normal concrete, 5-1/2-thick up to the second floor level around the cells and 4-1/2-ft-thick above the second floor. Currently, two of the cells are used for the ORNL ²³²Cf production program. The antiquated building fire alarm system is in critical need of upgrading or replacement because of the unavailability of replacement parts.
¹ Requires modification for use on RH TRU waste and containers. ² Limited for use on certain LANL-generated RH TRU waste streams. <i>Information in italics represents planned capabilities.</i>				